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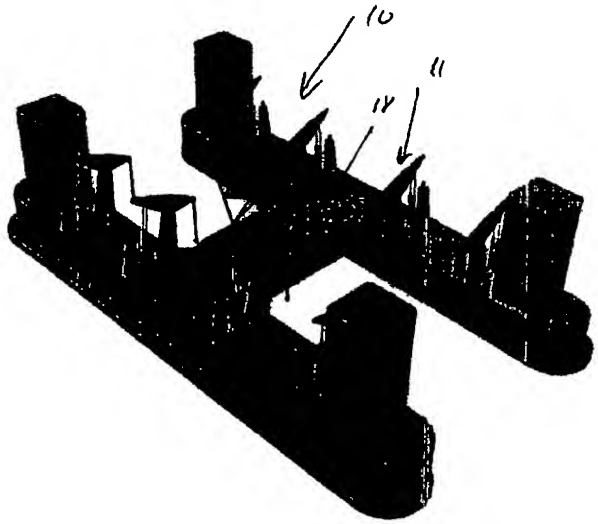
(54) Title: BALLASTABLE LIFTING VESSEL AND METHOD FOR LIFTING, TRANSPORTING, POSITIONING AND INSTALLATION OF A MARINE STRUCTURE, PARTICULARLY ONE OR SEVERAL WINDMILLS



(57) Abstract: A ballastable vessel (1) and a method for lifting, transporting, positioning and installing at least one marine structure (20), preferably one or more windmills, by establishing a connection between the lifting vessel (1) and the, at least one, marine structure (20). The lifting vessel (1) comprises a lower pontoon foundation (2), a number of columns (5) which are attached to the pontoon foundation (2) and which extend upwards, i.e. towards and through the water surface. The pontoon foundation (2) is H-shaped with two longitudinal pontoons (2c, 2b) and a transversal pontoon (2c), at least one column (5) is arranged on each of the longitudinal pontoon's end areas and each column (5) is free standing over the pontoon foundation (2).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Ballastable lifting vessel and method for lifting, transporting, positioning and installation of a marine structure, particularly one or several windmills

The present invention relates to a ballastable lifting vessel for lifting, transporting, positioning and installing at least one marine structure, preferably one or more windmills, by establishing a connection between the lifting vessel and the at least one marine structure, where the lifting vessel comprises a lower pontoon foundation, a number of columns which are attached to the pontoon foundation and which extend upwards, i.e. towards and through the water surface.

More precisely the present lifting vessel is formed as a hull where the buoyancy can be regulated/adjusted by ballasting/deballasting for lifting- and transport operations at sea.

The invention also relates to a method for lifting, transporting, positioning and installing at least one marine structure, preferably one or more windmills with the help of a ballastable lifting vessel, wherein a connection is established between the lifting vessel and the at least one marine structure, where the lifting vessel comprises a lower pontoon foundation, a number of columns which are connected to the pontoon foundation and which extend upwards, ie. towards and through the water surface, and at least one lifting/supporting structure arranged on the pontoon foundation and which can be inclined towards the vessel's docking area(s).

In connection with offshore activities, such as oil and gas exploitation, it is usual to install platforms on the field. These platforms often consist of large and heavy platform sub-structures, which are fixed to the seabed. Such a platform sub-structure is often a so-called 'jacket', which is a steel truss structure. On top of for example the jacket structure it is usual to place a platform deck, which is used in connection with drilling and production. The deck often also includes living quarters.

To transport and install the platform substructure and platform deck described above, for example barges have been used, which transport the platform

substructure and the platform deck out to the field, and large crane ships have been used to install the platforms on the field.

Ballastable vessels have also been used to transport and install platforms off-shore.

There are today a great number of platforms at sea, installed for exploiting oil and gas. When oil and/or gas reservoirs in a field are fully exploited, the oil platforms' life span is usually over, and in many cases it will be of interest to remove the platform.

Some platforms already have been removed, and platforms will continue to be removed at an increasing rate in the coming years.

The traditional way of removing a platform is to use large ocean-going crane vessels. The platform must be thoroughly prepared, and must be divided into pieces, since even large lifting vessels have limited lifting capacity. The same goes for the platform substructure (the jacket).

These operations are time consuming and costly, both because the crane vessels are large, expensive and require a large crew, and because cutting a platform up offshore is complicated. The whole operation is associated with risk.

The new technology can be called 'single lift technology', and will reduce costs considerably. It will also be less risky than today's methods.

There are 4 concepts that the Applicant is aware of today in the field of "Single Lift Technology". Norwegian Patent Application No. 1999 2759 belongs to the Applicant of the present invention and relates to a ballastable lifting vessel for positioning, lifting and handling a marine structure.

"Offshore Shuttle" is a vessel planned built as a steel truss structure. The vessel has a significant length and the lifting of, for example, a platform deck is based on crossbeams spanning across the structure.

"Master Marine" is developing a U-shaped semi-submersible vessel with a carrying structure (deck) connecting the top of columns. Lifting is based on load transfer to this deck-structure.

"Versatruss" is a concept involving separate barges, each supporting its own lifting frame. By pulling the barges together after positioning the lifting frames beneath the lifting points on the platform deck, the lifting of the deck can

take place. This method has already been used to remove small platform decks in calm waters.

Development in the area of "renewable energy" has resulted in even more windmills being installed around the world. Different environment considerations have resulted in windmills now being installed at sea instead of on land.

Windmills that so far have been installed at sea, have been installed with the help of crane ships. They are transported to the site in pieces and are mounted piece by piece. Consequently offshore operations are very time consuming, which again is costly and involves risk.

One objective of the present invention is to be able to complete the removal of a platform in a quick and cost-effective manner without having to divide the deck, or alternatively the jacket, into pieces. Removal should also be carried out in a safe manner, where the safety of the operators is ensured in the best possible way.

Another objective of the present invention is that the lifting vessel shall be as flexible as possible, so that it can be adapted to platform decks of varying width. Further, it should be possible to use the vessel both to lift and handle jackets of different sizes. The vessel should be a so-called Multi Purpose Unit (MPU), which can also transport, for example, the platform deck to land, for so to transfer the deck to a barge for sheltered waters, or alternatively, a pier suited to the vessel.

Another objective is that the lifting vessel shall be able to be transported on a heavy lift vessel, to reduce the travel time to distant destinations such as the Gulf of Mexico and the Persian Gulf.

Another objective of the lifting vessel is that it shall also be able to be used for installing platforms, which roughly is the opposite of removal. Furthermore, the lifting vessel should be able to be used for a range of other purposes where large carrying capacity is required.

A further objective with the vessel is that it shall be able to solve many different tasks. The vessel should be very flexible and permit different equipment to be installed to perform different tasks at sea. One objective in this respect is that

the vessel shall be able to be used to transport and install, and eventually, remove whole windmills at sea. The windmills shall be mounted together, at a suitable quay or dock and transported complete to the installation site at sea. This will reduce the cost and risk significantly, compared to existing methods.

The above-mentioned objectives are achieved according to the present invention by a ballastable lifting vessel according to the introduction of the description, and characterised by the pontoon foundation being H-shaped, with two longitudinal pontoons and a transversal pontoon, at least one column arranged on each of the longitudinal pontoons' end areas, and each column being free-standing over the pontoon foundation.

A preferred embodiment of the lifting vessel will be explained in more detail in claim 2.

The objectives of the invention are further achieved by a method for lifting, transporting, positioning and installing at least one marine structure, preferably one or more windmills, by means of a ballastable lifting vessel, according to the introduction of the description, and which is characterised by the following method's steps:

a) the vessel is positioned around a windmill which is located on the seabed,
b) the vessel is ballasted down to the seabed,
c) the vessel's lifting/supporting structure is attached to the windmill, and this is then lifted to the desired position,
d) the vessel is deballasted whereby the windmill and transversal pontoon is raised to a desired position above water,
e) the vessel is moved to the site where the windmill is to be placed,
f) the vessel is ballasted down to the seabed,
g) the windmill is lowered down to the seabed and the lifting/supporting structures are released, and
h) the vessel is deballasted and removed.

The present invention will now be explained with help of examples of use and with reference to the Figures, where:

Fig. 1 shows a lifting vessel according to the present invention,

Fig. 2 shows a first embodiment arrangement of the lifting/supporting structure for mounting on the lifting vessel in connection with handling two windmills,

Fig. 3 shows a second embodiment arrangement of a lifting/supporting structure for handling two windmills,

Fig. 4 shows the lifting vessel according to the invention with a lifting/supporting structure according to Fig. 2 mounted on it,

Fig. 5 shows the lifting vessel according to the invention with the lifting/supporting structure according to the embodiment in Fig. 3 mounted on it, and

Fig. 6 shows the lifting vessel according to the invention, which transports two windmills to a site using its own engine power.

The lifting vessel 1 according to the present invention will now be explained with reference to the Figures and in particular to Fig. 1.

The lifting vessel 1 consists of a floating hull with an H-shaped pontoon foundation 2 comprising two longitudinal pontoons 2a, 2b and a transversal pontoon 2c, and with columns 5 through the water surface for hydrostatic stability and optimal behaviour in the sea. The columns 5 are not connected structurally at the top, which is made possible by a rigid and robust hull structure. A brim 3 along the lower edge of the pontoon further improves the vessel's behaviour at sea. The vessel 1 is specially developed for operations at sea. The H-shaped pontoon 2a, 2b, 2c enables the vessel 1 to be positioned around a platform being installed or platform deck being lifted, or even a substructure being lifted. The lifting operation is performed according to Archimedes' principle by ballasting/deballasting the vessel 1. The lifting is mainly performed vertically, but the vessel 1 can be inclined/tilted slightly to accommodate special lifting operations.

Positioning of the vessel 1 is primarily considered performed by the vessel's own engine power. The vessel 1 is designed to be able to perform operations in oceans all over the world. To ease transportation from one sea area to another the vessel is constructed for transportation on a heavy-lift ship.

The vessel 1 is equipped with devices specially fitted for the operations the vessel 1 is intended for. Such operations, for example, are instillation and removal of platforms (substructures and platform decks) for the oil and gas industry.

Installation and removal of platform substructures are, as mentioned above, typical fields of operation for the present invention. The vessel 1 will now be described in relation to these operations, especially suited for lifting, transporting, positioning and installing two windmills at sea.

It should be noted however, that the H-shaped ballastable vessel 1, in connection with the mounting of windmills, will be significantly smaller than a corresponding vessel that is used for lifting platform decks and platform substructures. The ballastable vessel 1 for handling windmills will also preferably be of steel instead of concrete, which is used in connection with lifting platform decks and substructures. This is because weight is important when one should be able to enter very shallow water with cargo. It should otherwise be mentioned that choice of material and size are not important factors in connection with this patent application.

One of the principles with the vessel 1 is that it should be able to lift and transport a marine structure 20 to be installed/removed, in the most effective way possible. It is therefore necessary that the vessel 1 surrounds the structure/windmill 20, so that its weight is as central as possible in the vessel 1.

Fig. 2 shows a second embodiment of a lifting/supporting structure 10 which can be mounted on the vessel 1 to handle a marine structure in the form of a windmill 20. The lifting/supporting structure 10 comprises a tilting feature 11 consisting of a foundation 12 and a tilting arm 13, which balances on top of the foundation 12. The tilting arm 13 is connected at the one end to a

lifting stay 14, which again is connected to the marine structure (the windmill) 20 to be handled. The tilting arm 13 is connected at the other end to hydraulic cylinders 15 for raising and lowering the tilting arm 13. A locking structure 16 is arranged for locking the tilting arm 13 during transportation. A support structure 18 is also included in this embodiment arrangement of the lifting/supporting structure 10.

Fig. 3 shows a second embodiment arrangement of the lifting/supporting structure 10, where the support frame 18 is now placed between the tilting device pairs 11.

Fig. 4 shows the H-shaped lifting vessel 1 where the first embodiment arrangement of the lifting/supporting structure 10 is now arranged around the lifting vessel's two dock areas respectively.

Fig. 5 shows the H-shaped vessel 1 according to the invention where the second embodiment example of the lifting/supporting structure 10 is arranged around the lifting vessel's two dock areas respectively.

Fig. 6 shows two windmills being transported by means of the H-shaped vessel according to the invention.

When using the vessel 1 according to the invention, the tilting device 11 will grab and lift the marine structure's foundation and the support device 18 supports the marine structure 20 higher up.

Lifting takes place by the tilting arms 13, which are controlled by hydraulics 15, and which can be locked in a lifted position. The purpose of the lifting is to raise the marine structure 20 (the windmill foundation) out of the water and thereby reduce resistance in the water during transportation. For the same reason the vessels transversal pontoon 2c is raised so the vessel 1 floats like a catamaran during transportation. Speed is an important factor during transportation. The vessel 1 is preferably self-propelled, with engine power dimensioned for the speeds required.

The supporting frame 18 which supports the marine structure 20 higher up has two purposes; to support the marine structure 20 during trans

portation, and to help during positioning around the windmill 20. The lifting/supporting structure 10 can be arranged in several different ways, as described above and depending on the marine object 20 to be dealt with.

With reference to Figs. 10 and 11, a method for lifting, transporting, positioning and installing a windmill 20 by help of the U-shaped ballastable lifting vessel 1, with a device according to the invention which comprises a first embodiment arrangement of the lifting/supporting structure 10 mounted, will be explained in the form of the following main steps:

a) the vessel 1 is placed around a windmill 20 which is located on the seabed,

b) the vessel 1 is ballasted down to the seabed,

c) the vessel's lifting/supporting structure is attached to the windmill 20, and this is lifted into the desired position,

d) the vessel 1 is deballasted, whereby the windmill 20 and the transveral pontoon 2c are raised to a desired position above water,

e) the vessel 1 is moved to the site where the windmill 20 is to be placed,

f) the vessel 1 is ballasted down to the seabed,

g) the windmill 20 is lowered down to the seabed and the lifting/supporting structures 10 are released,

h) the vessel 1 is deballasted and removed.

Patent claims

1. A ballastable lifting vessel (1) for lifting, transporting, positioning and installing at least one marine structure (20), preferably one or more windmills, by establishing a connection between the lifting vessel (1) and the, at least one, marine structure (20) within the lifting vessel's docking area, wherein the lifting vessel (1) comprises a lower pontoon foundation (2), a number of free standing columns (5) which are attached to the pontoon foundation (2) and that extends upwards, i.e. towards and through the water surface, characterized by that the pontoon foundation (2) being H-shaped with two longitudinal pontoons (2a, 2b) and one transversal pontoon (2c), at least one free standing column (5) arranged on each of the longitudinal pontoons' end areas, whereby two docking areas are established on either side of the transversal pontoon (2c) and between the longitudinal pontoons (2a, 2b) and each docking area is arranged with a lifting/supporting structure (10) mounted on the pontoon foundation (2) for handling of a marine structure (20).

2. A ballastable lifting vessel (1) according to claim 1,

characterized by that the transversal pontoon (2c) is arranged at a higher level than the longitudinal pontoons (2a, 2b).

3. A method for lifting, transporting, positioning and installing at least one marine structure (20), preferably one or more windmills, by help of a ballastable lifting vessel (1), wherein establishing a connection between the lifting vessel (1) and the, at least one, marine structure (20) within the lifting vessel's docking area, wherein the lifting vessel (1) comprises a lower pontoon foundation (2), a number of free standing columns (5) which are attached to the pontoon foundation (2) and which extend upwards, i.e. towards and through the water surface, characterized by that

a) a first docking area of the vessel (1) is positioned around the marine structure (20) which is located on the seabed,

b) the vessel is ballasted down to the seabed,

c) a connection is established between the lifting/supporting structures (10) which are arranged on the pontoon foundation (2) and the marine structure (20),

d) the marine structure (20) is lifted to the desired position by use of the lifting/supporting structures (10),

e) the method's steps a, b, c and d are repeated when handling further marine structures (20) in the lifting vessel's (1) other docking area,

f) the vessel (1) is deballasted, whereby the marine structure(s) (20) and the transversal pontoon are raised to a desired position above water, and the vessel (1) is moved to the site where the marine structure(s) are to be placed,

g) the vessel is ballasted down to the seabed,

h) the marine structure(s) (20) are lowered down to the seabed and the lifting/supporting structures (10) are released, and

i) the vessel (1) is deballasted and removed.

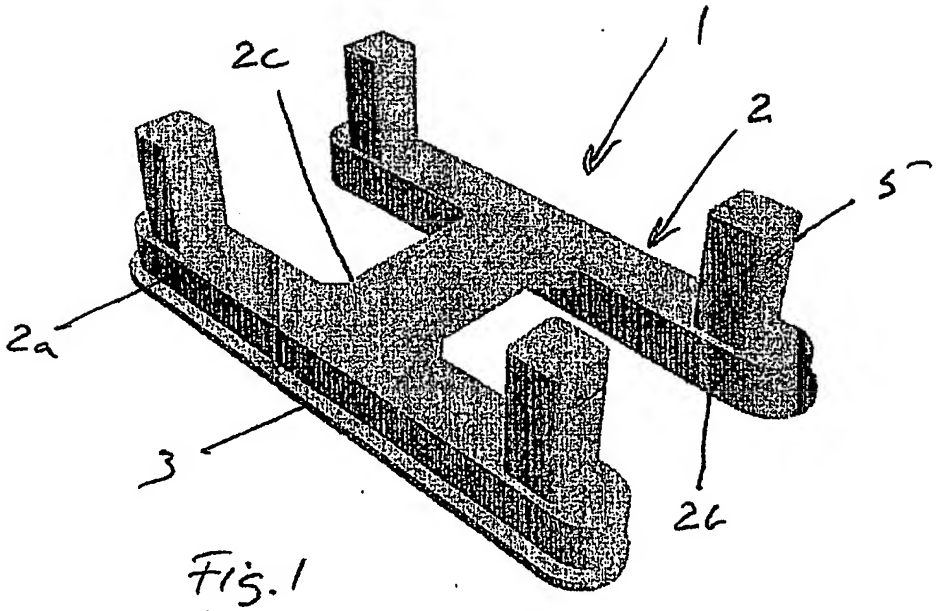

Fig. 1

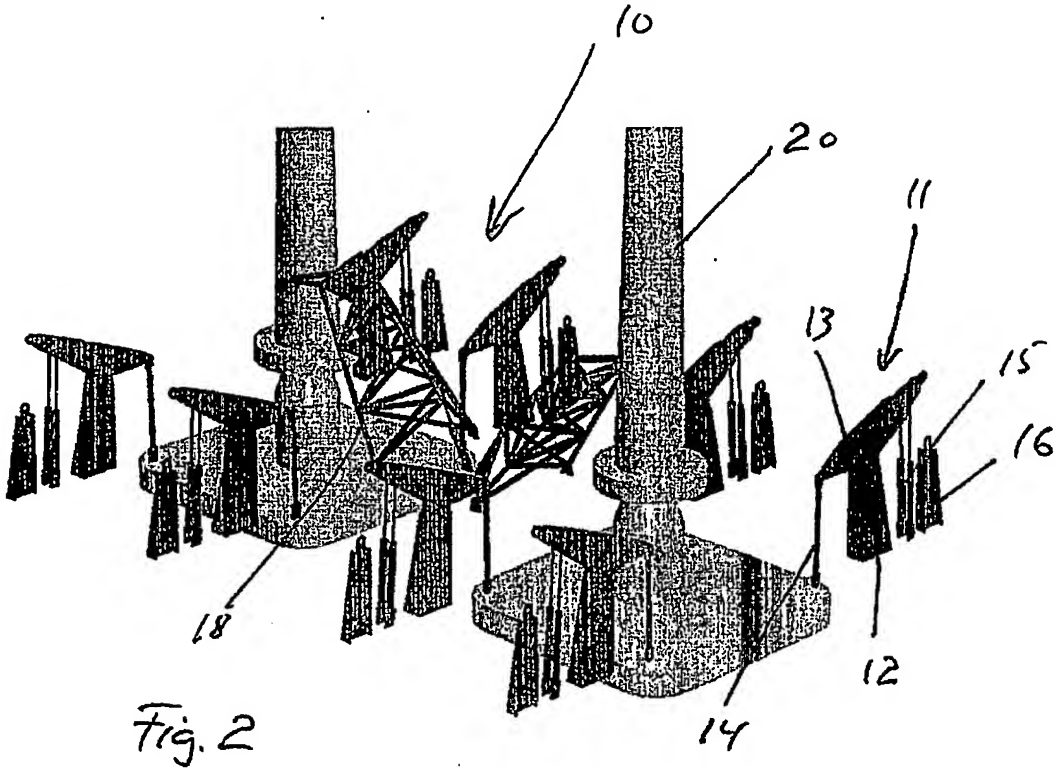

Fig. 2

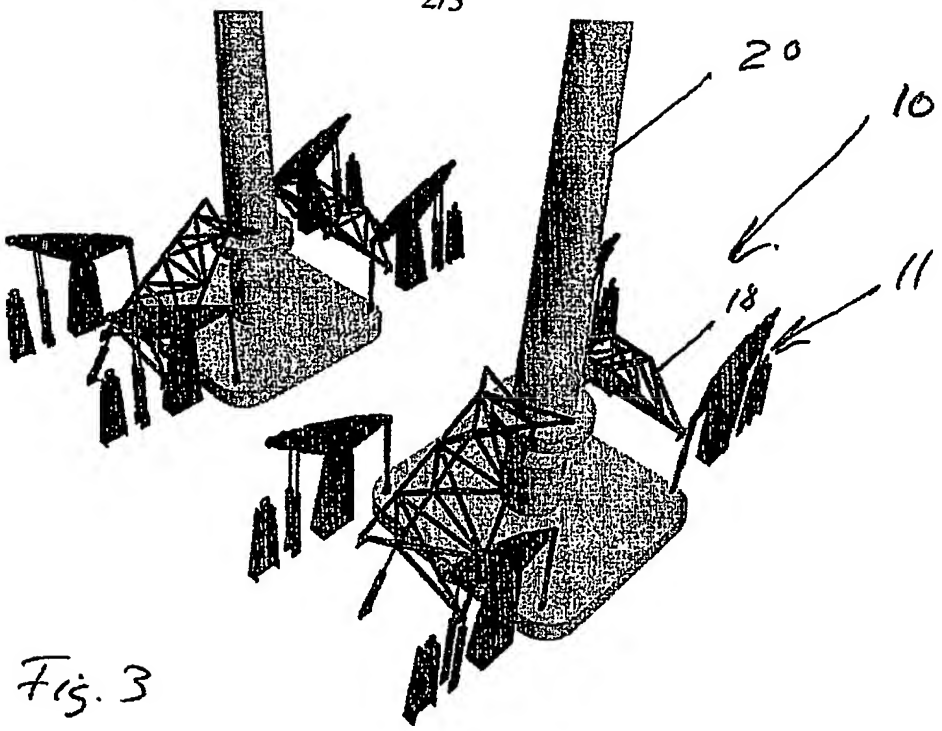

Fig. 3

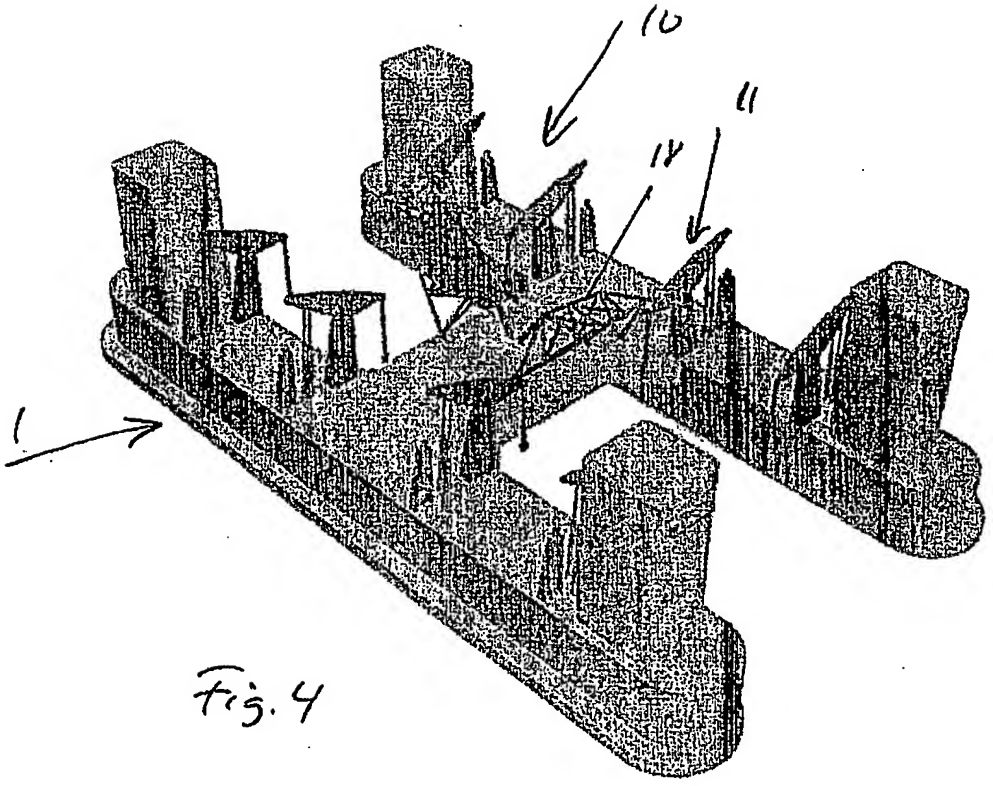

Fig. 4

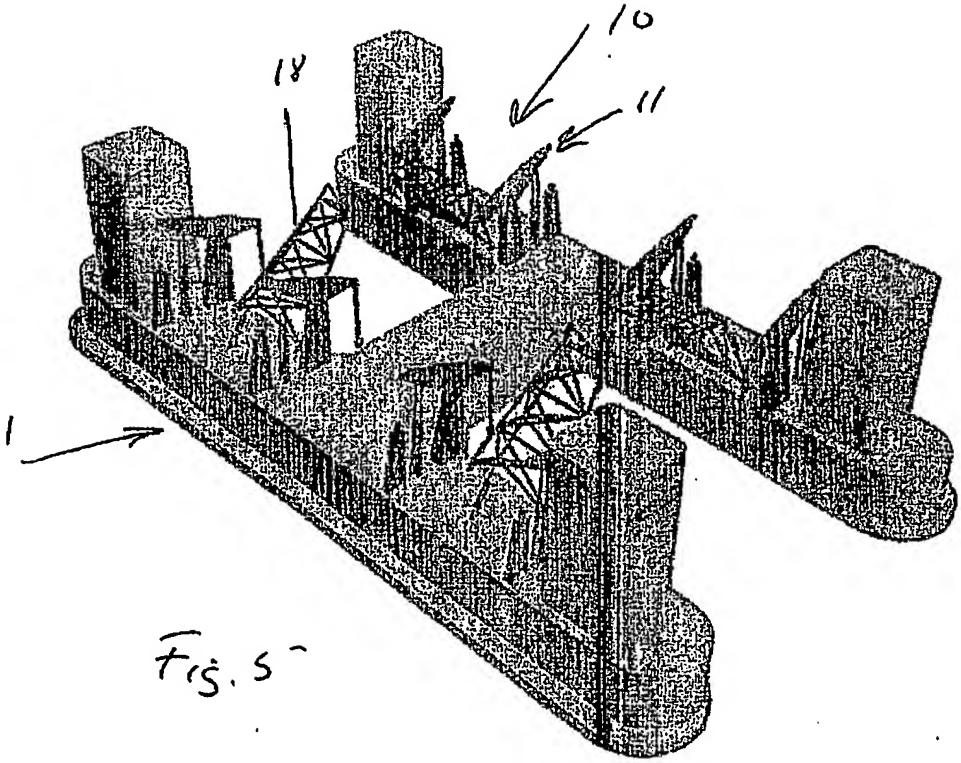

Fig. 5

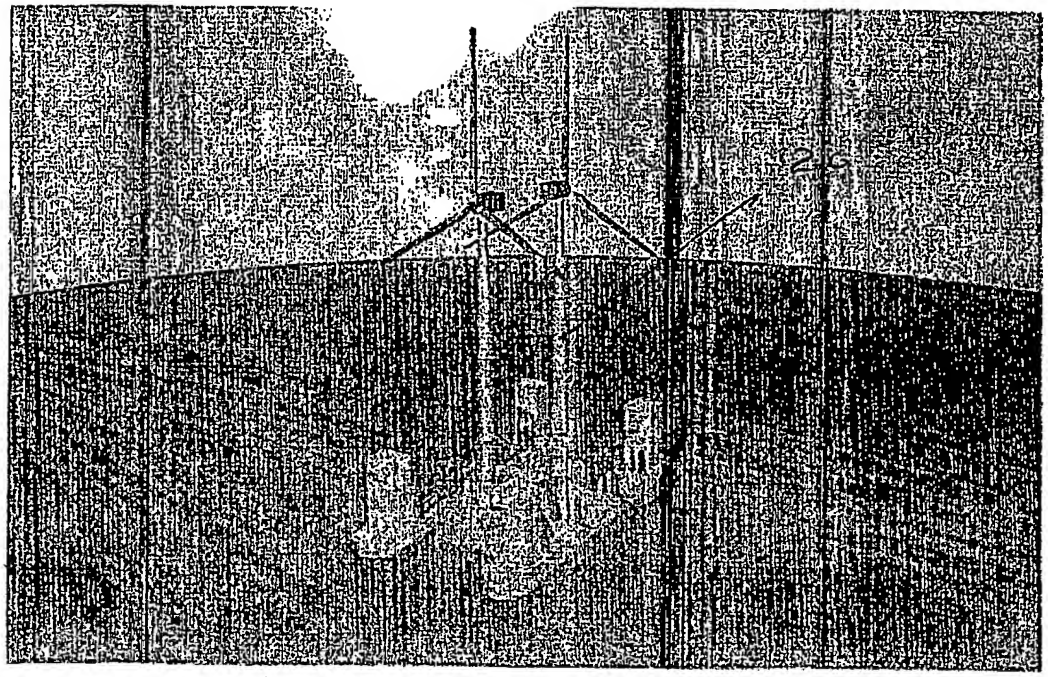

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B63B 35/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	WO 0078604 A1 (MPU ENTERPRISE AS), 28 December 2000 (28.12.00), figures 1-20, abstract --	1-3
X	WO 0160688 A1 (VATSVÅG, JAN), 23 August 2001 (23.08.01), figures 1-3, claims 1,8, abstract --	1-3
X	US 4556004 A (LAMY ET AL), 3 December 1985 (03.12.85), claims 1,8, abstract --	1-3

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
8 April 2003	09-04-2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Carl Fröderberg/EK Telephone No. +46 8 782 25 00

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

28/02/03

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